

**AN INVENTORY OF PLANT SPECIES IN THE PARAMO OF CAJANUMA,  
PODOCARPUS NATIONAL PARK (ECUADOR)**

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**ABSTRACT**

The results of a floristic inventory are presented for the Páramo of Cajanuma (3150-3385 m elevation), located in Podocarpus National Park, southern Ecuador. A total of 130 species, representing 81 genera and 50 families, are reported. Species composition is discussed in relation to environmental factors and regional-scale floristic patterns. Special emphasis is given to the occurrence of woody species.

**KEY WORDS:** páramo, floristics, Podocarpus National Park, Andes, Neotropics, Ecuador

**INTRODUCTION**

Neotropical montane regions are frequently covered with páramo vegetation between 3000 and 4700 m elevation. This ecosystem occurs discontinuously between Costa Rica and northern Perú in areas where annual precipitation is above 1500 mm and evenly distributed across the year (Lauer 1981; Luteyn 1992). Although páramo is usually dominated by herbaceous species, a zone of shrub páramo (*sensu* Cuatrecasas 1968) may occur between the grass páramo and timberline. In Ecuador, páramo covers less than 2% of the total area (Luteyn *et al.* 1992), but it may include more than 3300 vascular plant species (Luteyn, in press).

Despite both the high species richness and rates of environmental degradation that characterize Ecuador's upper montane zone (*e.g.*, Acosta-Solís 1984; Balslev 1988; Luteyn 1992), relatively few floristic inventories of páramo communities have been published for Ecuador (but see Løjtnant & Molau 1982; Cerón & Toasa 1994; Keating 1995). The floristic composition of montane communities in southern Ecuador differs substantially from those of adjacent regions (Jørgensen *et al.* 1995), but few páramo studies of any sort have been conducted there (but see Lægaard 1992; Keating 1995; Ramsay & Oxley 1996). In this article, I document a botanical inventory conducted in

the Páramo of Cajanuma, located in northwestern Podocarpus National Park (Figure 1). A species list is provided (Appendix 1), and I briefly discuss species composition in relation to ecological factors and regional floristic patterns.

### STUDY SITE AND METHODS

Located in the provinces of Loja and Zamora-Chinchipe, Podocarpus National Park is the only major protected area in the southern tip of Ecuador (Figure 1). It encompasses 146,280 ha of montane ecosystems, protecting the only remaining zone of intact forest in Loja Province. The northwestern section of the park is located immediately to the southeast of Loja, the only large city in the region.

The terrain of northwestern Podocarpus National Park is dominated by low, rugged mountains of orogenic origin. Fieldwork was conducted near the Cordillera Oriental de Los Andes, a high ridge that generally runs north-south between 2900 and 3424 m elevation. Numerous steep ridges adjoin the Cordillera Oriental, connecting it to deep valleys located to the east and west. Soils are classified as either vertisols or inceptisols (White & Maldonado 1991).

This study was conducted above the Cajanuma Park Station (2850 m), where plant species diversity is exceptionally high even by Ecuadorian standards (see Bøgh 1992; Madsen & Øllgaard 1994). Montane forests extend up to approximately 3100 m, above which point the vegetation is characterized by a heterogeneous mixture of timberline forest and páramo communities. The annual rainfall above 2800 m is between 2000 and 4000 mm (Apolo 1984). In the páramo, diurnal temperature typically varies between 3° and 10° C, and winds often exceed 100 kph (Keating 1995).

The study site was located at 4° 09' S, 79° 10' W on a ridge extending to the east of the Cordillera Oriental (Figure 1). The ridge is 60 to 100 m wide, and is flanked by ravines to the north and south. Between the Cordillera Oriental and the timberline, the ridge measures nearly 350 m in length. Unlike most páramos located north of the park, this site has not experienced intense anthropogenic disturbances in the recent past. Grazing does not occur near the study site, and the vegetation near Cajanuma has not burned since November, 1985.

From the top of the ridge (3385 m) down to 3335 m, the site is covered with grass páramo and patches of shrub-dominated vegetation between 5 and 15 m in diameter. Continuous shrub páramo occurs between 3335 and 3150 m, where the treeline occurs. Between September, 1991 and July, 1992, plant collections were made between the top of the ridge and 3250 m. Below this point, the ridge is covered with a complex shrub páramo/timberline ecotone; a study of this vegetation is still in progress. Plant community patterns and vegetation structure of Cajanuma have been analyzed by Keating (1995 and ms). This article lists all of the species that occurred in plots utilized for this study, as well as ones that were found outside the plots. Plant specimens were deposited primarily in the herbarium at the Pontificia Universidad

Católica del Ecuador (Quito), and duplicates were sent to the Herbario Nacional del Ecuador (Quito) and the Universidad Nacional de Loja.

## RESULTS AND DISCUSSION

A total of 50 families, 81 genera, and 130 plant species were collected in the Páramo of Cajanuma (Appendix 1). Sixty-six species (51%) are woody, whereas 64 (49%) are herbaceous. Taxonomically, 3 (2.3%) species are bryophytes, 13 (10%) are pteridophytes, and 114 (88%) are angiosperms. In terms of species richness, the most important families are Asteraceae (18), Ericaceae (14), and Melastomataceae (10). These three families tend to be among the most species-rich families in many Andean sites above 3000 m (see Gentry 1995). In contrast, 27 families are represented at Cajanuma by only one species.

In part because Cajanuma is located at a relatively low elevation, the grass páramo differs substantially from others sampled in northern South America (*e.g.*, Cleef 1981; Miller & Silander 1991; Hofstede 1995). Although grasses dominate most of the area above 3335 m elevation, only three members of Poaceae were collected, none of which are bunch grasses. *Chusquea loxensis* L.G. Clark is abundant throughout the site, although *Calamagrostis macrophylla* (Pilger) Pilger appears to be the most abundant grass species. Since many other grass taxa are known from adjacent areas (L. Clark & S. Læggaard, pers. comm.), it is very likely that some taxa were inadvertently missed.

Secondly, unlike páramos sampled at higher elevations, the Cajanuma páramo contains relatively few species of either the rosette or cushion life forms. Although four members of the Bromeliaceae, as well as *Valeriana convallarioides* (Schmale) B.B. Larsen, are found here, other rosette species found frequently at higher elevations in Colombia (*e.g.*, Cleef 1981) and Venezuela (*e.g.*, Pérez 1987) are absent at Cajanuma. Many species exhibiting this life form are adapted to sub-freezing soil temperatures (Pérez 1987), which do not characterize the Cordillera Oriental. Moreover, of the cushion plant taxa known to occur in the páramos north of Loja Province, only *Eriocaulon* spp. were collected at this site.

Finally, the Cajanuma grass páramo is atypical due to the richness of woody species ( $n=36$ ), as well as the abundance of woody individuals. Not only are patches of tall (1-2 m) shrubs found in the upper páramo, but nearly all of the grass-dominated sites contain some woody individuals. *Arcytophyllum setosum* (R. & P.) Schlecht., *Disterigma empetrifolium* (H.B.K.) Drude, *Gynoxys miniphylla* Cuatrec., *Miconia latifolia* (D. Don) Naud., and *Valeriana microphylla* H.B.K. are most abundant (Keating 1995), and at least ten other shrub species are common. Most woody species in the grass páramo were also seen in the shrub páramo, but the following woody species were restricted to the grass páramo: *Disterigma codonanthum* H.B.K., *Gaultheria amoena* A.C. Smith, *Miconia bullata* (Turcz.) Triana, *Miconia rotundifolia* (D. Don) Naud., and *Pentacalia myrsinites* (Turcz.) Cuatrec. Given that many relatively undisturbed sections of the Cordillera Oriental are covered with tall shrubs, fire may play an important role in maintaining this community (*e.g.*, Keating 1997).

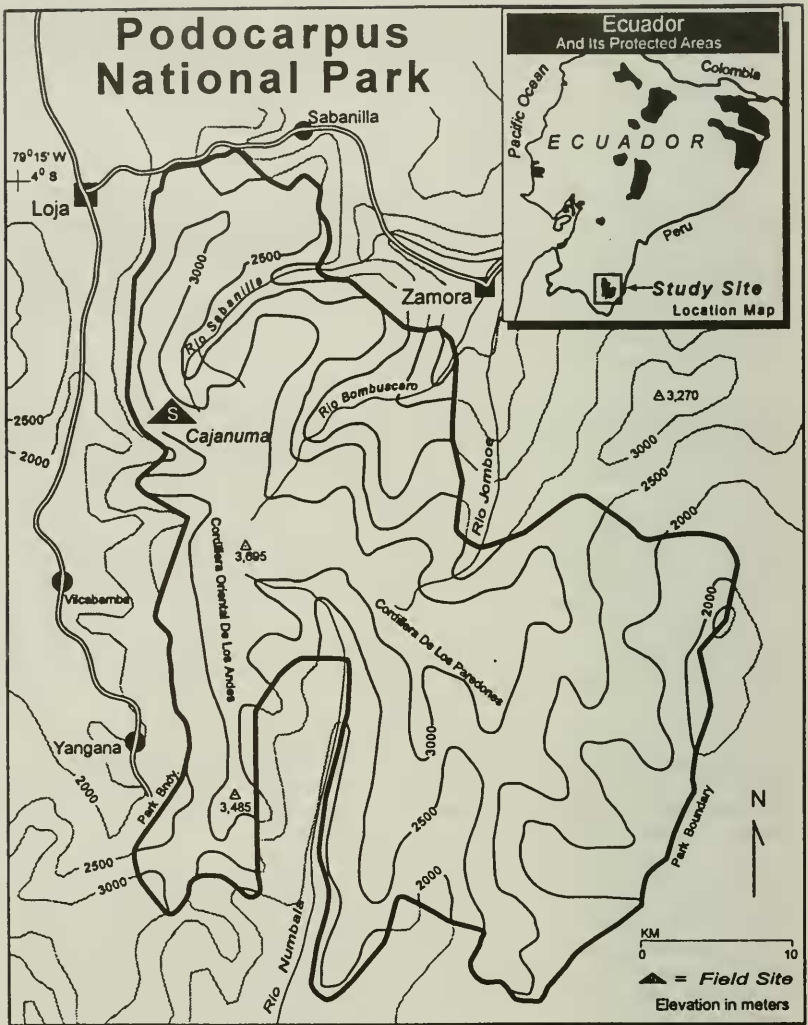


Figure 1. Map of Podocarpus National Park

Within the zone of continuous shrub páramo (< 3335 m), 61 woody species and 43 herbaceous species were collected. Although the majority of the woody species also occur above 3335 m, 23 were restricted to the lower shrub páramo (< 3320 m). Some of these species are probably uncommon in other Ecuadorian páramos, but it is difficult at this point to determine how rare these woody taxa are at the regional scale (see discussion below).

The vast majority of the 43 herbaceous species occurring in this community were also present in the grass páramo. Only four herbaceous species were unique to this community: *Baccharis huaracajensis* Hieron., *Greigia* or *Puya* sp., *Lophosoria quadripinnata* (Gmelin) C. Chr., and *Peperomia galioides* H.B.K. The most abundant herbaceous species in this community is *Tillandsia orbicularis* L.B. Sm., a rosette species of the Bromeliaceae. Whereas most *Tillandsia* species above the Cajanuma Park Station are arboreal epiphytes (e.g., Bøgh 1992), this species attains 100% coverage in much of the shrub páramo.

Although shrub páramo is often found above timberline in tropical montane regions (e.g., Cleef 1981; Smith & Young 1987; Frantzen & Bouman 1989), most recent páramo studies conducted in Ecuador pertain only to grass-dominated communities. Given that many high-elevation shrub species may be eliminated by frequent fires (e.g., Williamson *et al.* 1986; Horn 1989; Keating 1995), this community is severely threatened by the increasing frequency of anthropogenic disturbances above 3000 m (e.g., Læggaard 1992; Keating 1997). Extensive areas of shrub páramo have been eliminated throughout the Andes, and scientists will need to study this community more intensively to ensure that it receives greater protection in the future.

According to Luteyn (in press), the páramos of Podocarpus National Park not only exhibit unusually high species diversity, but differ significantly in floristic composition from those páramos located in more northern regions. It is difficult, however, to make quantitative comparisons between the site described above and those sampled in more northern sites. First, previous studies differ markedly with respect to both the sampling scheme utilized and the area surveyed. Second, while botanists have collected specimens in the Loja Province for more than five decades (e.g., Espinosa 1948), both the park and southwestern Ecuador in general remain undercollected (Jørgensen *et al.* 1995).

Although the majority of the 50 families found at Cajanuma are common throughout the high Andes, many of the species may be uncommon in other Andean páramo sites. As this study was conducted, many additional species were observed in other páramo communities along the Cordillera Oriental. More extensive investigations will be necessary to provide accurate estimates of the total species diversity and level of endemism that characterize páramos within the park. However, recent studies (Jørgensen & Ulloa Ulloa 1995; Young & Reynel 1997) have suggested that montane ecosystems of both southern Ecuador and northern Perú contain many endemic plant species. Because Podocarpus National Park includes thousands of hectares of relatively undisturbed páramo, it merits far more attention by páramo specialists than it has been accorded previously.

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## APPENDIX I

Plant taxa that occur in the Páramo of Cajanuma (3250-3385 m), Podocarpus National Park. A total of 50 families, 81 genera, and 130 species are included. Numbers in parentheses indicate the author's collection number(s).

Family, species, and voucher number	Habit
<b>I. Bryophytes</b>	
<b>BARTRAMIACEAE</b>	
<i>Breutelia chrysea</i> (C. Mull.) Jaeg. (509)	herb
<b>DICRANACEAE</b>	
<i>Campylopus jamesonii</i> (Hook.) Jaeg. (507)	herb
<b>RHACOCARPACEAE</b>	
<i>Rhacocarpus purpurascens</i> (Brid.) Par. (507a)	herb
<b>II. Pteridophytes</b>	
<b>ADIANTACEAE</b>	
<i>Jamesonia</i> cf. <i>imbricata</i> (Sw.) Hook. & Grev. (191)	herb
<b>BLECHNACEAE</b>	
<i>Blechnum</i> cf. <i>auratum</i> (Fée) comb. ined. (275)	herb
<b>GLEICHENIACEAE</b>	
<i>Gleichenia revoluta</i> H.B.K. (265)	herb
<b>HYMENOPHYLLACEAE</b>	
<i>Hymenophyllum</i> sp. (277)	herb
<b>ISOETACEAE</b>	
<i>Isoetes</i> sp. (278)	herb
<b>LOPHOSORIACEAE</b>	
<i>Lophosoria quadripinnata</i> (Gmelin) C. Chr. (253)	herb
<b>LYCOPODIACEAE</b>	
<i>Huperzia brevifolia</i> (Grev. & Hook.) Holub (188)	herb
<i>Huperzia</i> cf. <i>kuesteri</i> (Nessel) Øllgaard (114, 180)	herb



<i>Lycopodium clavatum</i> L. (152)	herb
<i>Lycopodium magellanicum</i> (Palisot) Sw. (235)	herb
<i>Lycopodium vestitum</i> Poir. in Lam. (163)	herb
POLYPODIACEAE	
<i>Polypodium</i> aff. <i>punctulatum</i> Hook. (269)	herb
THELYPTERIDACEAE	
<i>Thelypteris</i> ( <i>Amauropelta</i> ) sp. (284)	herb
III. Angiosperms	
APIACEAE	
<i>Niphogeton dissecta</i> Benth. (167)	herb
AQUIFOLIACEAE	
<i>Ilex</i> sp. (172, 239)	tree
ASTERACEAE	
<i>Ageratina cutervensis</i> (Hieron.) K.M. King & H. Rob. (403)	scandent forb
<i>Baccharis huaracajensis</i> Hieron. (200, 405, 512)	scandent forb
<i>Diplostephium asplundii</i> Cuatrec. (179, 406)	shrub
<i>Diplostephium espinosae</i> Cuatrec. (413)	shrub
<i>Diplostephium hartwegii</i> Hieron. (110, 132, 193)	shrub
<i>Diplostephium</i> sp. (139, 403)	shrub
<i>Eupatorium</i> sp. (137)	scandent forb
<i>Gynoxys cuichensis</i> Cuatrec. (129, 162)	shrub
<i>Gynoxys miniphylla</i> Cuatrec. (122, 169)	shrub
<i>Gynoxys</i> sp. (502)	tree
<i>Hieracium</i> cf. <i>frigidum</i> Wedd. (264)	herb
<i>Mikania brachyphylla</i> Hieron. (418)	herbaceous vine
<i>Oritrophium peruvianum</i> (Lam.) Cuatrec. (208)	herb
<i>Pentacalia myrsinites</i> (Turcz.) Cuatrec. (401)	shrub
<i>Pentacalia oronocensis</i> (DC.) Cuatrec. (203)	shrub
<i>Senecio pimpinellifolia</i> H.B.K. (190)	herb
<i>Senecio tephrosioides</i> Turcz. (198)	herb
unknown #1 (210)	herb
BERBERIDACEAE	
<i>Berberis</i> sp. (263)	shrub
BORAGINACEAE	
<i>Moritzia lindenii</i> (DC.) Gurke ex Benth. (22)	herb
BRASSICACEAE	
<i>Cardamine</i> cf. <i>ovata</i> Benth. (1, 42, 161)	herb
BROMELIACEAE	
<i>Greigia</i> sp. (257)	herb
<i>Greigia</i> or <i>Puya</i> sp. (255)	herb

- Puya maculata* L.B. Sm. (256) herb  
*Tillandsia orbicularis* L.B. Sm. (204) herb
- CAMPANULACEAE  
*Centropogon steyermarkii* Jepp. (135) shrub
- CARYOPHYLLACEAE  
*Stellaria recurvata* H.B.K. (136) scandent forb
- CLETHRACEAE  
*Clethra fimbriata* H.B.K. (151) tree  
*Clethra ovalifolia* Turcz. (112, 209) tree
- CLUSIACEAE  
*Hypericum aciculare* Kunth (105) shrub  
*Hypericum decandrum* Turcz. (194) shrub  
*Hypericum lancioides* Cuatrec. (126, 202) shrub
- CUNONIACEAE  
*Weinmannia elliptica* H.B.K. (119) tree  
*Weinmannia cf. fagaroides* H.B.K. (185) shrub  
*Weinmannia glabra* L.f. (157) tree  
*Weinmannia rollottii* Killip (28, 138) tree
- CYPERACEAE  
*Rhynchospora* sp. (508) herb
- ERICACEAE  
*Disterigma acuminatum* (H.B.K.) Nied. (164) shrub  
*Disterigma alaternoides* (H.B.K.) Nied. (156) shrub  
*Disterigma codonanthum* H.B.K. (117) shrub  
*Disterigma empetrifolium* (H.B.K.) Drude (133) shrub  
*Gaultheria amoena* A.C. Smith (276) subshrub  
*Gaultheria erecta* Vent. (4, 248) shrub  
*Gaultheria megalodonta* A.C. Smith (116) shrub  
*Gaultheria reticulata* H.B.K. (5, 244) shrub  
*Gaultheria strigosa* Benth. var. *strigosa* (3, 168) shrub  
*Gaultheria* sp. (270) shrub  
*Macleania rupestris* (H.B.K.) A.C. Smith (108) shrub  
*Pernettya prostrata* (Cav.) D.C. (6, 234) shrub  
*Themistoclesia epiphytica* A.C. Smith (21, 184) shrub  
*Vaccinium floribundum* H.B.K. (25, 251) shrub
- ERIOCAULACEAE  
*Eriocaulon microcephalum* H.B.K. (9) herb  
*Eriocaulon* sp. (175) herb
- GENTIANACEAE  
*Halenia cf. asclepiadea* (H.B.K.) G. Don (51, 196) herb

GERANIACEAE

- Geranium mollendinense* Kunth (7, 8, 102, 206) herb  
*Geranium sibbaldoides* Benth. (30, 205) herb

GROSSULARIACEAE

- Escallonia myrtilloides* L.f. (27) shrub  
*Ribes hirtum* H.B.K. (183) tree

HALORAGACEAE

- Gunnera magellenica* Lam. (33, 207) herb

IRIDACEAE

- Sisyrinchium* cf. *chilense* Hook. (32) herb

LILIACEAE

- Bomarea* cf. *densifolia* Vargas (103, 189) herbaceous vine  
*Bomarea* cf. *setacea* (R. & P.) Herb. (246) herbaceous vine

MELASTOMATACEAE

- Brachyotum andreanum* Cogn. (111) tree  
*Meriana* (*Centronia sanguinea* Wurd. (45, 166) tree  
*Miconia bullata* (Turcz.) Triana (24, 115) tree  
*Miconia cladonia* Gleason (201) tree  
*Miconia dodsonii* Wurd. (177) shrub  
*Miconia latifolia* (D. Don) Naud. (107, 211) tree  
*Miconia ligustrina* (Sm.) Triana (287) shrub  
*Miconia rotundifolia* (D. Don) Naud. (120) scandent shrub  
*Miconia salicifolia* (Bonpl. ex Naud.) Naud. (109, 121) tree  
*Miconia vaccinioides* (Bonpl.) Naud. (195) shrub

MYRSINACEAE

- Cybianthus marginatus* (Benth.) Pipoly (267) shrub  
*Myrsine dependens* (R. & P.) Spreng. (266) shrub  
*Myrsine* sp. (280) shrub

ONAGRACEAE

- Fuchsia loxensis* H.B.K. (41) scandent forb

ORCHIDACEAE

- Epidendrum* sp. (268) herb  
*Gomphichis* cf. *valida* Rchb.f. (2, 165) herb

OXALIDACEAE

- Oxalis* cf. *lotoides* H.B.K. (47, 101) scandent forb  
*Oxalis* sp. (503) herb

PIPERACEAE

- Peperomia galioides* H.B.K. (245) scandent forb

POACEAE

- Calamagrostis macrophylla* (Pilger) Pilger (504) herb

- Chusquea loxensis* L.G. Clark (505) herb  
*Neurolepis asymmetrica* L.G. Clark *ined.* (506) herb

## POLYGALACEAE

- Monnina* cf. *revoluta* H.B.K. (124, 134) shrub

## POLYGONACEAE

- Muehlenbeckia tamnifolia* (Kunth) Meissner (46, 118) herbaceous vine  
*Rumex tolimensis* Wedd. (279) herb

## ROSACEAE

- Hesperomeles heterophylla* (R. & P.) Hook. (23) shrub  
*Lachemilla* cf. *nivalis* (Kunth) Rothm. (128, 199) herb  
*Rubus acanthophyllos* Focke (262) scandent shrub  
*Rubus coriaceus* Poir. (261) scandent forb  
*Rubus loxensis* Benth. (100, 187, 260) scandent forb

## RUBIACEAE

- Arcytophyllum capitatum* (Benth.) K. Schum. (247) shrub  
*Arcytophyllum setosum* (R. & P.) Schlecht. (106, 181) shrub  
*Nertera granadensis* (Mutis ex L.f.) Druce (280) herb  
*Relbunium hypocarpium* (L.) Hemsl. (281) herb

## SMILACACEAE

- Smilax* sp. (285) herbaceous vine

## SCROPHULARIACEAE

- Bartsia* sp. (282) herb  
*Calceolaria comosa* Pennell (237) shrub  
*Calceolaria oxyphylla* Molau (31, 104, 130, 170) tree

## SOLANACEAE

- Unknown sp. 1 (43, 501) treelet  
 Unknown sp. 2 (44) treelet  
 Unknown sp. 3 (283) treelet

## SYMPLOCACEAE

- Symplocos clethrifolia* Ståhl (174) tree  
*Symplocos* cf. *quitensis* Brand (160) tree  
*Symplocos* sp. 1 (286) shrub  
*Symplocos* sp. 2 (192) shrub

## VALERIANACEAE

- Valeriana convallarioides* (Schmale) B.B. Larsen (178) herb  
*Valeriana microphylla* H.B.K. (113, 123, 171) shrub  
*Valeriana plantaginea* H.B.K. (131, 182) herb  
*Valeriana* sp. (173) shrub

## XYRIDACEAE

- Xyris subulata* R. & P. (29) herb